

# **RECOMMENDED CHANGES AND ADDITIONS TO OCTOBER 1999 DRAFT REPORT ON EVALUATION OF BIOMASS-TO-ETHANOL FUEL POTENTIAL IN CALIFORNIA**

## **EXECUTIVE SUMMARY**

- **Add paragraph to acknowledge the work that is underway by the California Interagency Biomass Group (see below under Chapter I).** *An Interagency Biomass Group consisting of a broad cross-section of state agencies and departments has been meeting for several months to share information about biomass-related interests and activities. The Group is currently working to develop a vision to focus activities. This work should provide a good platform for developing a comprehensive statewide biomass policy developed through interagency cooperation.*
- **Add the following paragraph that summarizes public input received at November 19, 1999 Hearing (see full text below for Changes and Additions to Appendix).** *On November 19, 1999, a public hearing was held at the California Energy Commission to receive comments on the draft report on the "Evaluation of Biomass-to-Ethanol Fuel Potential in California." Over 40 interested parties attended the hearing and 12 speakers delivered comments. Appendix ES-B-2 summarizes comments received at the public hearing.*

## **CHAPTER I: EVALUATION OF STEPS TO FOSTER BIOMASS-TO-ETHANOL DEVELOPMENT IN CALIFORNIA**

- **Add the following paragraphs:** *An Interagency Biomass Group consisting of the California Resources Agency, CalEPA, California Department of Food and Agriculture, California Department of Forestry, California Energy Commission, California Air Resources Board, California Integrated Waste Management Board, and the California Water Resources Control Board has been established with the purpose of sharing information about biomass-related interests and activities of various state agencies and departments.*

*Four meetings have been held to date. In addition to information sharing that has occurred from these meetings, the discussions have indicated that state government organizations recognize significant public benefits from the use of California biomass to produce energy or other useful products (particularly, the productive use of biomass residues or waste). The current activities of the Interagency Biomass Group are to develop a vision to target actions for the near future.*
- **Add the following paragraph as a header to Market Development and Commercialization Options, page I-5:** *The staff reviewed a number of documents on what other states have offered in the way of incentives, tax credits, and special programs to foster ethanol production and use. A summary for all states actively pursuing some form of direct or indirect encouragement of ethanol appears in Appendix I. In addition, a summary of particular mechanisms employed by the State*

*of Minnesota is included in this Appendix. The effectiveness, costs, and economic benefits of the Minnesota program are discussed and serve to illustrate the results of one of the most pro-active state programs in the United States. All of this information has been used in developing options and pro and con arguments pertaining to tax credits, loans, producer payments, bonds, and loan guarantees.*

- **Add the following pro and con argument to chapter 1 Market Development and Commercialization page I-5**

**Provide a feedstock payment (credit) for waste biomass resources used to make fuel or produce energy.**

***Pro-** An alternative to producer payments or loan guarantees ,which would target feedstocks yielding the greatest environmental benefit through avoidance of agricultural burning, controlled forest burns, or resource disposal in landfills. The size of payment can be tied to the environmental benefit associated with better use of feedstocks. Results in use of feedstocks without extensive government interaction to limit open air burning of biomass. Credit is not limited to ethanol production.*

***Con-** Costs of feedstock collection are allocated to the general public and not to beneficiaries of biomass use. Extensive enforcement of environmental requirements could result in costs of feedstock collection being borne by agriculture, forest, and waste industries. Credit could apply to multi-product processes such as ethanol and gardening mulch.*

**Provide project financing through bonding authorities such as the California Alternative Energy and Advanced Transportation Financing Authority**

***Pro –** This financing authority is a potential source for federal tax exempt bonds. The federal government authorizes California \$50 per capita per year in federal bonds thus creating a \$1.6 billion funding pool. Ethanol production from waste biomass such as rice straw may qualify within the definition of projects eligible for this type of financial assistance.*

***Con-** The federal government has severely restricted issuance of tax exempt bonds through the tax reforms in 1986. Higher priority subscribers for these bonds currently use 70 to 80 percent of the funds and no new major energy projects have been funded through this authority since 1993.*

## **CHAPTER II: ETHANOL AS A FUEL—BACKGROUND**

- **On page II-2, expand discussion on Oxydiesel, other advanced technologies and use of ethanol in fuel cell vehicles by adding the following:** *In Illinois, for example, demonstrations using Oxydiesel are being conducted with buses at the Chicago*

*Transit Authority and with Archer Daniel Midlands Company heavy-duty vehicles in Decatur.*

- *Opportunities also exist for developing high efficiency ethanol vehicles that incorporate direct injection, hybrid-electric or other advanced technologies. Engines designed specifically for ethanol use can be optimized to capture efficiency, emissions and performance benefits.*
- *In addition to internal combustion engines, ethanol could be used in fuel cell vehicles, which may offer the ultimate benefits in efficiency and emissions. Proton exchange membrane (PEM) fuel cells are the leading technology for vehicle applications today. While today's PEM fuel cells operate on hydrogen, hydrocarbon fuels, including ethanol, can be utilized with a reformer. On- and off-board reformers are used to extract hydrogen from fuels such as methanol, gasoline, natural gas and ethanol. EPYX Corporation, which was spun off from A.D. Little Corporation, has been working on a multi-fuel processor that would reform various fuels including ethanol. In addition, SRI International is working on high temperature polymer electrolytes that will allow the use of ethanol as direct fuel in PEM fuel cells.*

### **CHAPTER III: WASTE BIOMASS RESOURCES IN CALIFORNIA**

- **On Page III-9 add the following sentence to first paragraph under subcategory Forest Thinnings:** *Thinning may also increase the available water to the ecosystem.*
- **On Page III-2 add the following sentence:** *See Appendix III-A for more information on these alternatives.*
- **On Page III-3, change reference to Appendix III-A to Appendix III-B.**
- **On Page III-6, change reference to Appendix III-B to Appendix III-C.**
- **On Page III-16, change reference to Appendix III-C to Appendix III-D.**
- **The above changes result in one new appendix and the renumbering of three other appendices for Chapter III.**

### **CHAPTER IV: BIOMASS CROP RESOURCE POTENTIAL IN CALIFORNIA**

- **No major changes made to Chapter IV.**

### **CHAPTER V: BIOMASS CONVERSION PROCESSES**

- **No major changes made to Chapter V.**

### **CHAPTER VI: ETHANOL PRODUCTION POTENTIAL FROM WASTES AND RESIDUES IN CALIFORNIA**

- **On Page VI-5, change the first sentence of the third paragraph to read:** *There are now in operation in California 30 biomass power plants owned by independent power producers (as displayed in Figure VI-1 and tabulated in Appendix VI-C).*
- **On Page VI-9, change reference to Appendix VI-C to Appendix VI-D.**

## **CHAPTER VII: ECONOMIC EVALUATION**

- Chapter VII has been significantly reorganized to improve clarity. The order of the chapter has been changed to cover all aspects of the Midwest corn-based ethanol production and supply first, followed by analysis of potential biomass-to-ethanol production in California (rather than mixing the two sections).
- Economic analysis has been updated to reflect additional modeling resulting in revised numbers, figures, and tables throughout the chapter.
- Delete Section titled “What are the Economic Opportunities and Risk Factors Associated with a California Ethanol Industry” on Page VII-22. These items are already discussed in other chapters of the report.
- Working definitions and distinctions are provided for various types of ethanol costs, and prices (i.e., ethanol price, target price, production cost, plant gate cost, etc.) used in the chapter.
- More discussion of how the 54 cent per gallon federal tax incentive is reflected (or not reflected) in the economic analysis is provided throughout the chapter.
- Add the following subsection title and paragraph that summarizes review of biomass benefits studies: *Summary of Biomass Benefits Studies*

*Staff reviewed three different reports (referred to at the November 19, 1999 hearing) describing the benefits of biomass electric power plants in California. The studies completed in 1997 by Natural Resources Strategic Services, Reese-Chambers Systems Consultants study for the California Biomass Energy Alliance, and Future Resources Associates examined a variety of benefits to California of operating biomass power plants.*

*The benefit areas described in the report include: reduced air emissions, greenhouse gas reductions, diversion from landfill disposal, wildfire reduction, improved forest health, increased water yield, higher rural income and expanded employment opportunities and electricity generation (energy diversity). The total value of benefits estimated by these studies ranged from \$246 million to \$473 million annually. See Appendix VII-C for more information on these benefits.*

*None of the above studies provided estimated benefit values for a biomass-to-ethanol industry. Additional work will be needed to expand current knowledge and assessment of potential benefits that may accrue from collocating a biomass power plant with an ethanol facility or building a new biomass-to-ethanol plant.*

## **APPENDICES**

### **APPENDIX ES-EXECUTIVE SUMMARY (ADD NEW APPENDIX ES-B-2)**

#### **Summary of November 19, 1999 Hearing on Report for Governor: “Evaluation of Biomass-to-Ethanol Fuel Potential in California”**

A public hearing was held on November 19, 1999 at the California Energy Commission to receive comments on the Energy Commission’s Fuels and Transportation Committee’s draft report on the *Evaluation of Biomass-to-Ethanol Fuel Potential in California*. Commissioners Michal C. Moore and Robert Pernell of the California Energy Commission led the hearing. Jim Boyd, Energy Advisor to the California Resources Agency, and Dr. Alan Lloyd, Chairman of the California Air Resources Board, also participated from the dais. Bill Vance from CalEPA was also in attendance throughout the hearing.

Over 40 interested parties attended the hearing. Comments were received from 12 speakers including an Energy Commission staff presentation by Pat Perez.

What follows is a summary of key points by those commenting on the draft report:

**Greg Krissek:** Assistant Secretary of the Kansas Department of Agriculture, on behalf of Kansas Governor Bill Graves, current chair of Governors’ Ethanol Coalition

- Governors’ Ethanol Coalition now comprises 23 states and 4 international members.
- Ethanol plays an important environmental and economic role in the portfolio of U.S. energy sources.
- Believes the report provides a detailed examination of biomass fuel alternatives.

**Todd Sneller:** Nebraska Ethanol Board/Governors’ Ethanol Coalition

- Illinois stimulated ethanol production by creating a “buy Illinois” policy that created a performance-based production credits program. Producers were paid after they performed.
- Nebraska established contract program to provide assurances to reduce risk for government.
- Nebraska has 350 million gallons per year of ethanol capacity and is working to modify grain-based plants to accept biomass.

**Neil Koehler:** Parallel Products

- Likes the interagency cooperation that exists between state agencies.
- A false sense of petroleum supply security exists and fuel diversity is needed.
- Need an integrated environmental, energy, and air quality policy.
- Need a long-term (>10 years) stable market for ethanol in the transportation market.

- California has been a “hostile” market for ethanol use in the past decade.
- Recommends a renewable fuels standard policy be developed for California (e.g., 5% of fuels and 5% of electricity supplies should be from renewable sources).
- Ethanol as a fuel source for fuel cells should be investigated.
- Opposes financial assistance where the State of California chooses the winners and losers.
- The state should not take an equity position in any ethanol plants and believes no direct investment is necessary.

**Phil Reese:** Colmac Energy and California Biomass Energy Alliance

- Represents 28 of the 30 currently operating biomass power plants in California.
- Disagrees with statement on page I-8 of report that says “no definitive study of benefits has yet been conducted” regarding the quantification of the value of a biomass-to-ethanol industry to the state. Three studies exist including one NREL study that was cosponsored by Energy Commission that quantifies the benefits.
- Biomass power plants can compete in deregulated market if zero-cost feedstock is made available.
- Feedstock fuel cost is the main consideration in plant economics.
- Questioned why the “Cost-Shifting” report by CalEPA is still in the Governor’s Office.
- The diversion credit (AB 939) has “no teeth” even with recommended revision to full 50%.
- In 1992-94, 45 biomass power plants were in operation using 8 million tons of biomass annually. Today there are only 29 plants using about 5 million tons of biomass annually. By 2002, there will be only 10 plants or fewer operating and the infrastructure for collocating with ethanol plants will disappear.
- We don’t need a biomass-to-ethanol policy; rather we need more interagency cooperation.
- The rationale for the “Pro” argument for creating a biomass policy on page I-1 in the report should be expanded to acknowledge that the existing biomass power industry could be used as a springboard for biomass-to-ethanol development.
- Wants the Energy Commission to extend the renewable production credit for biomass power plants.
- Noted that the biomass industry was unable to get the federal production tax credits for “closed-loop biomass extended to biomass power plants through the closed-loop credit.”
- The Research, Development and Demonstration Options listed on pages I-3 to I-5 should expand the work that has been done to reduce the cost of feedstock at the gate.
- The “Con” rationale on page I-4, that the federal government is already applying significant resources to reduce the cost of feedstock, is not supported in the report.
- The recommendation to develop a biofuels policy on page I-3 may lead to funding that is ill spent (i.e., the efforts of consumers to buy green energy has been a failure).
- Public goods are paid for by government.
- The state should not underestimate the difficulty of securing financing.

- Recommends staff consider what must occur before we have a sustained market and what is the schedule for seeing this happen? Can government step in to save the biomass power industry in two years?

**Bill Carlson:** Wheelabrator and Chairman of the USA Biomass Power Alliance

- A known market exists, but ethanol is not valuable
- Recently returned from Washington D.C. where the battle was lost to change definition of closed-loop biomass because of Representative Archer's (Texas) opposition.
- Avoid creating direct competition between existing biomass power industry and biomass-to-ethanol industry.
- The existing biomass power industry needs incentives to ensure continued operation.
- Likes optional policy noted on page I-1 to develop a biomass policy and believes that biomass should be utilized for ethanol production and for generating electricity
- Efforts should be encouraged to lower cost of raw materials or increase value of products.
- Report should focus on biomass wastes and not energy crops.
- The values of lignin and moisture value content appear to be wrong in the report.
- No more studies are needed. We need to implement steps to make things happen.

**Necy Sumait:** Arkenol

- A very comprehensive report.
- Ethanol is the largest "sink" for biomass.
- Carbon reduction and diversity goals should be adopted.
- Fuel diversity is a necessity, not an option.
- The California Integrated Waste Management Board needs to be involved.
- Policy focus should be on demonstrations and developing long-term markets.
- Supports full diversion credit for biomass-to-ethanol.

**Chris Trott:** OGDEN Pacific Power, Inc.

- Supports developing a comprehensive biomass policy to assist biomass-to-ethanol industry.
- Currently working with the Energy Commission and federal government on two proposals to collocate ethanol facilities with existing biomass power plants.
- Supports broad-based policy to address waste and environmental issues.
- All state agencies should be working together on a joint solution.
- A healthy biomass power industry is essential to a California biomass-to-ethanol industry.
- The Energy Commission should concentrate on utilizing waste biomass first before exploring the use of energy crops.
- If the biopower industry declines, the associated feedstock infrastructure will also decline.

- The Energy Commission should act as the catalyst for the development of a comprehensive statewide biomass policy developed through interagency cooperation.

**Norm Hinman:** BC International

- Have developed plans to build biomass-to-ethanol facilities in Gridley and Chester, California and completing the financing to construct a 20 million-gallon per year ethanol facility in Louisiana.
- Encourage policies to ensure 10-year market for biomass ethanol.
- Provide state government backed 15-year low interest (3-4%) loans
- Recommended exploring use of low interest loans from California's Pollution Control Finance Authority.
- Examples of what other states such as Minnesota have done demonstrate that the benefits greatly outweigh the costs of providing loans.
- One 1997-study for the Midwestern Governors' Conference shows that for every dollar spent to support ethanol, more than six dollars is returned to the economy as government revenue.
- Biomass-to-ethanol can provide protection against gasoline price spikes.
- To ensure a market for ethanol, the state should consider implementing policies that require state vehicles to operate on ethanol blends, develop a renewable fuel standard to require a minimum percentage of ethanol or other renewable fuel be sold, create greenhouse gas standards for fuels, and California could provide an insurance policy to ensure a market and act as a broker for buying and selling ethanol if demand is not large enough.

**Steve Shaffer:** California Department of Food and Agriculture

- The driving force for using agricultural wastes is current and future environmental regulations and the need for new markets, crop shifting and infrastructure investment.
- Recommends adding discussion on oxydiesel, ethanol use in fuel cells, and listing potential actions for supporting E-10 and E-22 vehicles.
- Take best shot at a suite of specific recommendations to provide a foundation for a task force to work on and provide a timeline by November 2000 to act on the recommendations.

**John Chilcote:** Placer County RCD

- Mechanization is the solution as labor costs are very high for collection and transportation of feedstock.
- Need for husbandry exemptions, removal of registration fees, and other restrictions that prevent forest residue harvesting and transporting equipment to use on state's highways.
- Need to involve water interests in forum.
- Excess biomass removal leads to more water being available later in the year when it is most needed.



- Expand vehicle code exemptions that exist for agriculture to silviculture.

**John Provost:** Pacific Lumber Company

- Lumber mills use 1500 tons of fuel.
- As forestry rules have changed, the use of helicopters for logging has increased, minimizing impacts to forest floor.
- Helicopter use in logging may preclude collection of forest residues.
- In-forest chipping is questionable.

**Jim Boyd:** Energy Advisor to Secretary of Resources

- Add discussion on the Interagency Biomass Group's efforts.
- Supports an interagency approach to developing a suite of recommendations.
- We should develop consistent environmental, energy, forestry and agricultural policies.
- Strong personal interest in biomass use and conversion.

**Alan Lloyd, Ph.D.:** Chairman of Air Resources Board

- We need to make it happen (the report should not end up in a waste bin).
- We want to see ethanol plants built and retained.
- Pledged continued cooperation with the Energy Commission and pleased about work underway to evaluate ethanol use for fuel cells.

**Robert Pernell:** Commissioner of California Energy Commission

- Complimented interested parties and staff for presentations and said report will not end up in a wastebasket.
- Looks forward to continued interagency cooperation
- Believes government should look for ways to help ethanol industry grow and recommended funding from the state's "Infrastructure Bank" be explored.

**Michal C. Moore:** Commissioner of California Energy Commission

- We are in a market driven period and it will be difficult to retain subsidies for biomass power industry.
- Don't count on a return to the "dark days" of subsidies.
- Supports efforts to enhance markets, eliminate obstacles, and create tipping fees for waste disposal.
- Fuel cycle costs need to be made visible to customers
- Raise the profile of benefits of biomass industry.
- The biomass industry is clearly undervalued.
- Very pleased with other agency participation and would like to see more involvement by forest and water agencies.

## **APPENDIX I-A EVALUATION OF STEPS TO FOSTER BIOMASS-TO-ETHANOL DEVELOPMENT IN CALIFORNIA**

- **Add new Appendix I-A-1 on Minnesota's Ethanol Incentive Program:**

### **Minnesota's Ethanol Incentive Program**

In 1996, the State of Minnesota Legislative Audit Commission requested an evaluation of the costs and benefits of several State programs designed to promote the production and use of ethanol as an automotive fuel. The resultant report<sup>1</sup> authored by the Office of the Legislative Auditor addressed issues of costs, program success, economic and environmental benefits, and major risks affecting future viability of production of ethanol in Minnesota. The report authors note that Minnesota provides substantially more support to ethanol when compared to programs and incentives of other states. The following sections extract major findings of the report to illustrate the Minnesota approach in developing a corn-based ethanol industry.

### **Background and Program Description**

Minnesota's support of ethanol production includes producer payments, subsidized loans, use of tax increment financing at the local level, and an ethanol blender's tax credit. At the time the report was written, Minnesota had 8 plants with a combined production capacity of 92 million gallons per year. Since that time, the number of plants has increased to 14 with a production capacity of 215 million gallons per year and three new plants with 50 million gallons per year capacity are planned for the future (see Appendix VII-C). The dramatic increase in the production of ethanol in the state since enactment of these incentives is a result of several measures combined with a statewide oxygen-in-gasoline requirement that goes beyond the geographic and time-of-year requirements of the federal Clean Air Act. This 2.7 weight percent requirement (10% by volume ethanol) is being met through the use of ethanol even though methyl-tertiary-butyl-ether could be used as the oxygen source for gasoline.

Minnesota used several grant and subsidized loan programs including economic recovery grants from its Department of Trade and Economic Development and two loan programs administered by the Minnesota Department of Agriculture. The latter include loans for ethanol producers as well as loans for farmers to purchase shares in ethanol producing co-operatives. Large loans at low interest rates are provided through the Ethanol Production Facility Loan Program and provide up to \$500,000 per plant. The array of incentive programs offered for ethanol facility construction and production are more fully defined in the following sections.

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<sup>1</sup> "Ethanol Programs – A Program Evaluation Report," Office of the Legislative Auditor, State of Minnesota, Report # 97-04, February 1997.

## **Ethanol Producer Payments**

The producer payment program provides ethanol producers 20 cents per gallon of ethanol produced up to \$3 million per plant with a statewide limit of \$30 million. This appears to be one of the most attractive incentive elements administered by the State. The report notes that Department of Agriculture officials, lenders, and plant managers all indicated that producer payments were critical in financing production facilities. A 15 million-gallon per year “dry mill” facility costs \$25 to \$30 million to construct. 20 cents per gallon for such a facility generates a revenue stream of \$3 million per year for the cost of the plant (\$30 million) over ten years. Financial institutions are willing to finance half the project cost (\$15 million) over a 7 to 10 year period given this guaranteed revenue stream. The report also notes that under such an arrangement financial institutions do not have to be concerned about the long-term viability of the ethanol production facility.

## **Ethanol Blender Credit**

In addition to the producers payment of 20 cents per gallon, Minnesota had a blender’s tax credit of 20 cents per gallon of ethanol blended in gasoline until October of 1994. This credit was reduced in each of the subsequent three years and phased out in October of 1997. The decision to phase out the tax credit coincided with legislation that raised the annual maximum of funding for ethanol producer payments.

## **Ethanol Production Facility Loan Program**

This program was established in 1993 by the legislature to help finance ethanol plants with low-interest loans of up to \$500,000 per plant. As explained, this type of loan was meant to encourage private lenders through demonstration of a state commitment to complete or fill-in gaps in plant financing arrangements. The report notes that with capital costs in the range of \$25-30 million for a 15 million gallon a year dry mill facility, this program plays a minor role in comparison to yearly producer payments which are several times the value of the one-time low interest (6%) loan. Financing comes from the Ethanol Development Fund created by the legislature. Repayments of loans are returned to the fund thus creating a revolving account to assist other projects.

## **Value-Added Agricultural Product Loan Program**

This program, also known as the Stock Loan Program, was enacted to help farmers finance the purchase of stock in a co-operative proposing to build or purchase and operate a facility to process agricultural crops. The loan can be used to finance the purchase of stock in various farmer owned co-operatives including ethanol plants. Funding for this program was at \$450,000 in 1995 according to the report. A maximum of \$24,000 in state funds is available to farmers from local lenders. Local lenders must match the state share with a 55% to 45% ratio. Loans are for eight years (maximum) with the state’s share at 4 percent or one-half the lender rate, whichever is lower.

## **Economic Recovery Grants**

Minnesota administers economic recovery grants through its Department of Trade and Economic Development. The report states a maximum of \$150,000 for several ethanol plants. This level of funding indicates that this fund plays an additional role in supporting construction of ethanol production facilities, however, the funding level is small in comparison to yearly ethanol producer payments.

## **Tax Increment Financing**

In 1995 the legislature set a limit of \$1.5 million for what is termed “tax increment financing.” According to the report, most operating ethanol plants in the early 1990s received this type of financing. Again, in comparison to ethanol producer payments, this incentive mechanism appears to be quite small.

## **Costs of Incentive Programs**

The Auditor’s report identifies three major cost elements to the state and consumers in supporting Minnesota’s ethanol industry. The producer payment cost was \$ 22.1 million for the three-year period of 1994 to 1996 with total program costs since inception in 1987 of \$39 million. This latter number when divided by total ethanol production over this time period (281 million gallons), yields an average producer payment of about 14 cents per gallon. The report projects additional producer payments of \$ 66 million for 1997 through 1999.

With the phase-out of the blender’s tax credit in 1997, the cost of this incentive is projected to be about \$8.7 million from 1997 through 1999 or about one-seventh the producer payment projections over this time period. For the 1994 through 1996 time period, the tax credit cost was \$ 61.2 million or about three times the cost of producer payments reflecting the state’s early strategy which focused on a tax credit for ethanol blending with gasoline.

With regard to consumers, the cost of ethanol in Minnesota gasoline is projected to add about 2 to 3 cents to the base gasoline price projection (in 1997). For the Minnesota market of about 2 billion gallons per year, the report indicates a range of \$33 to \$50 million per year, or an average of about \$125 million over the three year period of 1997 through 1999.

In summary, the Auditor projects total government costs at about \$67 million per year for a three-year period beginning in 1997 and ending in 1999.

## **Economic Benefits**

In assessing the benefits, the report notes that Minnesota’s programs are directly responsible for the development of a sizable ethanol production capacity. These findings were based on direct interviews with publicly owned ethanol producers, cooperative

ethanol producers, corn farmers, financial institutions, local government officials, and citizens.

In estimating the benefits in 1997, the report indicates that ethanol programs produce net economic benefits. Jobs, tax revenues, economic growth in rural areas, and improvements in city and small community roads and utility infrastructure occur as a result of the siting of ethanol facilities. The analysis also indicates creation of jobs is uncertain outside of the rural communities and, in fact, statewide jobs may decrease as a result of the state's role. The analysis for 1997 shows a net decrease in jobs statewide.

In round numbers, the analysis shows that the current (1997) levels of industrial development generate about \$269 million in economic activity (not including profits or losses of corn producers). Projected corn profits (or losses) could be \$58 million in 1997. Taking producer payments, the blender's tax credit, higher fuel costs, and lower fuel economy into account results in projections of cost between \$67 and \$102 million. ***Thus, the report concludes that the net economic benefit projected for 1997 should be in the range of \$109 and \$260 million.*** In addition there is a one-time benefit of \$174 to \$261 million projected from plant construction activities.

With regard to personal income, the analysis concludes that the ethanol industry has a net positive impact on total state personal income under all but the most unfavorable combination of assumptions. An increase of \$44 million of personal income is projected, but this may be adjusted up or down by \$7 million depending on whether corn growers profit or lose in the corn market.

### **Projections of Economic Benefits in 2001**

The report also provides a projection for economic benefits in 2001 assuming that 178 million gallons of ethanol will be produced that year. The annual statewide benefits (after subtracting producer payments) are estimated to be in the range of \$341 to \$549 million, however, the authors note that this is a best case estimate. Actual results will probably be lower.

### **A Producer Payment Incentive Scenario for California**

The review of Minnesota's ethanol program in the previous section forms a basis for consideration of a hypothetical producer payment scenario in California. The scenario developed here is based on planned California facilities discussed in Chapter II and is meant to provide a rough idea of potential costs should this mechanism be chosen to support the first few biomass-to-ethanol facilities built in California. The producer payment has been chosen for this scenario because of the apparent relative effectiveness of this incentive mechanism in Minnesota as reflected in the Legislative Auditor's report of the Minnesota Program in 1997.

In developing the scenario, it is assumed that financial institutions may require additional inducements beyond producer payments or a higher-level producer payment to lower

their risk in investing in the first projects in California. This is based on the fact that waste biomass-to-ethanol facilities require the use of technology not yet commercial anywhere in the United States. To capture this additional financial risk, two levels of producer payment are considered. The first is \$0.20 per gallon reflecting the level of Minnesota's producer payment for proven conventional technology (corn-to-ethanol dry or wet mill projects). The second is \$0.40 per gallon to capture what financial institutions might require for the first few projects using yet-to-be demonstrated large-scale cellulose-to-ethanol conversion technology. The \$0.40 per gallon actually corresponds to the producer payment offered by the State of North Dakota for "agricultural fuel" production (i.e., corn-derived ethanol). Three projects are assumed to provide a combined ethanol production capacity of 50 million gallons per year. All are assumed to come on-line in 2003 and the producer payments are assumed to last for ten years for each project. The table below summarizes cumulative producer payment outlays for the scenario.

<b>Cumulative Producer Payments for 50 M gallons per year (First Three California Projects Scenario- \$ millions)</b>		
<b>Year</b>	<b>\$0.20 per gallon</b>	<b>\$0.40 per gallon</b>
2003	10	20
2004	20	40
2005	30	60
2006	40	80
2007	50	100
2008	60	120
2009	70	140
2010	80	160
2011	90	180
2012	100	200

The scenario indicates yearly outlays of producer payments of \$10 to \$20 million with the cumulative total reaching \$100 to \$200 million after 10 years. To put the 50 million gallons a year in context, this volume represents about one-third of the low case ethanol demand in Appendix II-B (148 million gallons per year) or about five percent of the high demand case of about 1 billion gallons per year under an MTBE phase-out scenario. When compared with yearly state gasoline tax revenues, \$20 million dollars a year in producer payments represents less than one percent of gasoline fuel excise taxes assessed by the State of California.

This scenario should not be construed as a recommendation that the producer payment mechanism is the only or the most appropriate form of financial assistance to be considered for an emerging biomass-to-ethanol industry in California. In addition, the \$0.20 and \$0.40 per gallon producer payments while representative of what other states are currently providing for conventional corn-to-ethanol facilities, may not necessarily represent the right level of support for biomass-to-ethanol facilities that produce high value co-products and ethanol. However, it is worth noting that California does have an existing unfunded producer payment “grant” program in statute that could serve as a mechanism to initiate producer payments.<sup>2</sup>

### **APPENDIX III WASTE BIOMASS RESOURCES IN CALIFORNIA**

- **Replace existing Appendix III-A with new Appendix and renumber existing Appendices III-A,B and C to III-B,C and D.**

### **Appendix III A: Summary of Biomass-Derived Transportation Fuels and Conversion Processes**

The following Table III-A-1 is a list of many of the transportation fuels that can be derived from cellulosic biomass feedstocks. The list is not intended to be exhaustive, but rather to present a variety of relevant process technologies, and the end products (potential transportation fuels in this case) that can be derived from cellulosic biomass. The status of the technologies varies widely. Products other than transportation fuels that can be produced from biomass include soil amendments, livestock feed, building materials, commodity and specialty chemicals, etc.

Three principal routes for converting biomass are: 1) thermochemical (e.g., thermal gasification), 2) biochemical (e.g., fermentation) and 3) physicochemical (e.g., esterification, extrusion, etc.). In practice, combinations of two or more of these routes may be used in the processing of the biomass feedstocks into these products. (1)

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<sup>2</sup> Public Resources Code Section 25678 describes this program which was added through SB 2637, Statutes of 1988. As authored, this grant program would provide a 40-cent per gallon production incentive for liquid fuels fermented from biomass and biomass resources in California. Ethanol, methanol, and vegetable oils are mentioned specifically, however, the statute does not preclude other liquid fuels that might be produced from biomass. There is no history of any funds ever being allocated for this program.

Table III-A-1 Transportation Fuels Producing from Cellulosic Biomass

PROCESS	PRODUCT	COMMENTS
Fermentation	Ethanol	Traditional means for producing ethanol. Basic steps include 1) pretreatment, 2) hydrolysis, 3) separation of acids and sugars, 4) fermentation and 5) product purification (distillation). [Discussed in detail in Chapter V and the accompanying Appendix V-A.]
Gasification	Ethanol	By heat or other means, biomass is turned to a mixture of gases referred to as syngas, suitable for further conversion. Gasification of biomass can produce very high ethanol yields as cellulose, hemicellulose and lignin are utilized in the conversion process.
Hynol	Methanol	The Hynol process combines biomass feedstocks with natural gas to improve the efficiency of biomass conversion. The basic process consists of two reactions: 1) hydrogenation of the carbonaceous feedstock to produce methane, followed by 2) the endothermic reaction of methane with steam to produce H <sub>2</sub> and CO. (2)
Gasification	Methanol	Biomass gasification can produce synthesis gas (syngas), a mixture of Carbon monoxide and hydrogen. Syngas is feedstock in commercial Methanol production.
Biofine	MTHF	MTHF (methyl tetrahydrofuran) is a fuel additive that can be produced from levulinic acid, which can be produced from cellulose by the Biofine process (3). MTHF is a co-solvent facilitating larger percentage mixtures of ethanol into gasoline.
Esterification	Esters	Can be produced from vegetable and animal fats or oils. Through a process called transesterification, organically derived oils are combined with alcohol and chemically altered to form fatty esters such as ethyl or methyl ester. The biomass-derived esters can be blended with conventional diesel fuel or used as a neat fuel (biodiesels) (4)
Catalysis	Ethers	Common ethers include Methyl Tertiary Butyl Ether (MTBE) and Ethyl Tertiary Butyl Ether (ETBE). These ethers can be produced by converting biomass to an alcohol. MTBE is produced by a catalytic reaction between methanol and isobutylene over an acidic ion exchange resin. Similarly, ETBE is produced by a catalytic reaction between ethanol and isobutylene over an acidic ion exchange resin.(5)
Collection and Cleaning	Methane	Landfill gas, composed primarily of methane, is produced by the decomposition of waste deposits and is considered a problem if it is not contained. Can be processed and cleaned to operate boilers, vehicles, etc.
Anaerobic Digestion	Methane	Fermentation by anaerobic bacteria is used to produce biogas, a gaseous fuel consisting primarily of methane, with lesser amounts of carbon dioxide, water and small quantities of hydrogen sulfide.
Fischer-Tropsch	Fischer-Tropsch fuels	In this conversion process, hydrocarbons are synthesized from carbon monoxide and hydrogen over iron or cobalt catalysts. The CO and H <sub>2</sub> feed gases are produced from carbon-containing feedstock by gasification of biomass or other materials (e.g., natural gas, coal ). The process steps may include 1) gasification and gas clean up, 2) reforming, 3) F-T synthesis, 4) CO <sub>2</sub> removal, 5) hydrocracking and hydrocarbon recovery. (6,7) A variety of hydrocarbon fuels can be produced by these methods, including synthetic gasoline and diesel fuels.
Gasification and pyrolysis	Hydrogen	Hydrogen produced from high-temperature gasification and low temperature pyrolysis of biomass.(1)



These examples illustrate the many processes available to produce a variety of fuels from biomass. The first two entries are assessed further in this biomass-to-ethanol report.

The references cited for entries in this table are as follows:

- 1) Jenkins, Bryan; *Energy Systems*, Course compendium, University of California, Davis.
- 2) Sethi, P., Chaudry, S., and Unnasch, S. "Methanol Production from Biomass Using the Hynol Process", Overend and Chornet, *Biomass: A growth opportunity in green energy and value-added products*, Vol. 1, Proceedings from the 4<sup>th</sup> Biomass Conference of the Americas, 843.
- 3) Elliott, D., Fitzpatrick, S., Bozell, J., Jarnefeld, J., Bilski, R., Moens, L., Frye, J., Wang, Y., Neuenschwander, G., "Production of Levulinic Acid and Use as a Platform Chemical for Derived Products", Overend and Chornet, *Biomass: A growth opportunity in green energy and value-added products*, Vol. 1, Proceedings from the 4<sup>th</sup> Biomass Conference of the Americas, 595.
- 4) NREL, Internet Web site: [www.nrel.gov](http://www.nrel.gov), October 1999
- 5) Department of Energy, Internet Web site [www.ott.doe.gov/biofuels/what\\_are.html](http://www.ott.doe.gov/biofuels/what_are.html), October 1999
- 6) Larson, E. and Jin, H., "Biomass Conversion to Fischer-Tropsch Liquids: Preliminary Energy Balances", Overend and Chornet, *Biomass: A growth opportunity in green energy and value-added products*, Vol. 1, Proceedings from the 4<sup>th</sup> Biomass Conference of the Americas, 843.
- 7) National Renewable Energy Lab, et al; Environmental Life Cycle Implications of the Use of California Biomass in Production of Fuel Oxygenates, 1998

## **APPENDIX VI-B**

- **Utilize recent improved version of Appendix VI-, including (1) revise, more informative text, (2) three simplified maps showing locations of candidate solid waste handling facilities in California, and (3) an extensive Table VI-B-1, consistent with the three maps, providing more detail on each facility.**

## **APPENDIX VI ETHANOL PRODUCTION POTENTIAL FROM WASTES AND RESIDUES IN CALIFORNIA**

- **Add the following tables to Appendix VI-C**

# Cogeneration

# California Energy Commission Biolist California Direct Combustion Biomass Facilities – November, 1999

#	Project Name	City	County	Gross (MW)	Contract (MW)	Utility	Fuel	kBDT per yr.	Status	Remarks	Contact	Phone	Operated Year	Date of Shutdown
16	Louisiana Pacific, Samoa	Samoa	Humboldt	30.0	25.0	PG&E	W	484	steam	produced steam only	Jesse Sterling	707-443-7511	1980	1992
45	Diamond Walnut Power Plant	Stockton	San Joaquin	4.5	4.2	PG&E	Ag	36	open		Gary Ford	209-467-6000	1980	
63	Fibreboard Corp.	Standard	Tuolumne	3.0	3.0	PG&E	UW,W	71	closed		Jim Brisco	209-532-7141	1980	1994
42	Blue Diamond Growers Cogen	Sacramento	Sacramento	11.2	8.0	PG&E	UW,Ag	68	closed		Earl Ruby	916-446-8621	1981	
46	Wheelabrator Hudson	Anderson	Shasta	6.9	5.8	PG&E	W	54	open		Bill Carlson	530/365-9172	1982	
6	Koppers Industries	Oroville	Butte	6.0	4.8	PG&E	W	29	dismantled				1983	1996
23	Big Valley Lumber	Bieber	Lassen	7.5	3.0	PG&E	W	15	open		Marty Seuss	916-294-5226	1983	
25	Sierra Pacific Susanville	Susanville	Lassen	14.0	9.8	PG&E	W	189	open		Bob Ellery	530-378-8179	1984	1995
27	Susanville Forest Products	Susanville	Lassen	2.5	1.0	PG&E	W	32	closed		Kurt Schwartz	916-257-5808	1984	1993
3	Martell Cogeneration	Martell	Amador	20.0	9.0	PG&E	W,UW	126	open		Bill Carlson	530-365-9172	1985	
10	Auberry Energy, Inc.	Auberry	Fresno	9.0	6.0	PG&E	W,V,Ag	160	closed	phone disconnected	Doug Thompson	209-855-4001	1985	1994
33	Georgia Pacific Corp.	Fort Bragg	Mendocino	15.0	15.0	PG&E	W,UW	172	open		Art Owings	707-964-5651	1985	
40	Collins Pine Company	Chester	Plumas	12.0	10.0	PG&E	W	98	open		Jim Stewart	916-258-2111	1985	
44	California Cedar Products	Stockton	San Joaquin	0.7	N/A	N/A	W	10	closed		Patrick Lam	209-944-5800	1985	
59	Sierra Pacific Hayfork	Hayfork	Trinity	7.5	7.0	PG&E	W	85	closed		Bob Ellery	530-378-8179	1985	
60	Dinuba Energy	Dinuba	Tulare	11.5	8.3	PG&E	V,W,Ag	179	closed		Jim Schwager	209-591-8060	1985	1995
38	Sierra Pacific Lincoln	Lincoln	Placer	9.1	5.0	PG&E	W,V	91	open		Martin Law	916-645-1631	1986	
41	Sierra Pacific Quincy	Quincy	Plumas	17.5	12.5	PG&E	W	396	open		Bob Ellery	530-378-8179	1986	
48	Sierra Pacific Burney	Burney	Shasta	14.5	9.5	PG&E	W	217	open		Bob Ellery	530/378-8179	1986	
31	North Fork Energy, Inc.	North Fork	Madera	9.0	3.0	PG&E	W,Ag	145	dismantled				1987	1993
17	Pacific Lumber Company	Scotia	Humboldt	25.0	20.0	PG&E	W	419	open		John Prevost	707-764-4280	1988	
36	Soledad Energy Partnership	Soledad	Monterey	12.0	12.0	PG&E	UW,W	48	closed		Harry Hunzle	408-678-2600	1989	1994
50	Burney Forest Products	Burney	Shasta	29.0	24.0	PG&E	W	200	open		Milton Schultz	530-335-5100	1989	
53	Sierra Pacific Loyalton	Loyalton	Sierra	20.0	10.0	SPPC	W	111	open		Bob Ellery	530-378-8179	1989	
	Jackson Valley Energy	Ione	Amador	21.0	18.0	PG&E	UW,Ag	140	closed		Rollie Coombs	209-274-2407	1987	?

Key	
Ag - agricultural wastes	
An - animal wastes	
MSW - municipal solid wastes	
UW - urban wood wastes	
V - virgin wood	N/A - Not Applicable
W - wood wastes	NO - Not Obtained

# Electricity-Only

# California Energy Commission Biolist California Direct Combustion Biomass Facilities - November, 1999

#	Project Name	City	County	Gross (MW)	Contract (MW)	Utility	Fuel	kBDT per yr.	Status	Remarks	Contact	Phone	Operated Year	Date of Shutdown
52	Burney Mountain Power	Burney	Shasta	11.0	9.8	PG&E	W	77	open		Larry Ingals	213-335-5434	1984	1996
5	Pacific Orville Power	Oroville	Butte	18.0	16.5	PG&E	UW,W,Ag	142	open		Joe Brown	916-532-0597	1985	
19	Ultrapower, Blue Lake	Blue Lake	Humboldt	11.4	10.5	PG&E	W	90	closed		Randy Scott	707-668-5631	1985	
26	Ogden Westwood	Westwood	Lassen	11.5	10.0	PG&E	W	75	open		Gary Pritchard	916-365-0163	1985	1994
15	Fairhaven Power Company	Eureka	Humboldt	19.0	17.3	PG&E	W	252	open		Ron Auzenne	707-445-5434	1986	
62	Sierra Power	Terra Bella	Tulare	9.4	9.4	SCE	NO	74	closed		Orley Bennet	209-535-5325	1986	1993
64	Ultrapower, Chinese Station	Jamestown	Tuolumne	25.4	22.0	PG&E	UW,W	174	open		Steve Simmons	209-984-4660	1986	
28	Chowchilla Biomass Plant I	Chowchilla	Madera	10.0	7.5	PG&E	W,Ag	24	dismantled		Bill Lax	209-665-5791	1987	1994
51	Wheelabrator Shasta Energy	Anderson	Shasta	54.9	49.7	PG&E	W,,AG,UW	384	open		Bill Carlson	530-365-9172	1987	
12	Rio Bravo Fresno	Fresno	Fresno	28.0	24.3	PG&E	UW,Ag	167	open		Dick Rodenbach	209-264-4575	1988	1994
20	Mesquite Lake Project	El Centro	Imperial	18.0	15.0	SCE	An	200	closed		Michael O'Leary	619-344-2028	1988	1994
35	El Nido Biomass Plant	El Nido	Merced	12.5	9.9	PG&E	Ag,UW	52	closed		Bill Lax	209-665-5791	1988	1994
66	Feather River Energy	Marysville	Yuba	19.8	15.0	PG&E	W,Ag	37	dismantled				1988	1994
7	Wadham Energy	Williams	Colusa	30.0	26.5	PG&E	Ag	191	open		Ed Tomeo	925-244-1100	1989	
24	Honey Lake Power	Wendel	Lassen	35.0	30.0	PG&E	W,UW	187	open		Ralph Sanders	530-254-6161	1989	
30	Madera Power Plant	Madera	Madera	28.0	25.0	PG&E	UW,Ag	120	closed		Bill Lax	209-665-5791	1989	1994
39	Ultrapower, Rocklin	Lincoln	Placer	27.0	22.0	PG&E	UW,W	134	open		Jim Hancock	916-645-3383	1989	1994
65	Woodland Biomass Power	Woodland	Yolo	28.5	22.0	PG&E	UW,W,Ag	198	open		Randy Bates	530-661-6095	1989	
11	Mendota Biomass Power	Mendota	Fresno	28.5	22.0	PG&E	UW,Ag	179	open		Bob Notoheis	209-655-4921	1990	
21	Imperial Resource Recovery	Imperial	Imperial	18.1	15.0	SCE	Ag,An,UW	126	closed				1990	
22	Delano I	Delano	Kern	31.0	27.0	SCE	UW,Ag	145	open		John Jensen	805-792-3067	1990	
29	Chowchilla Biomass Plant II	Chowchilla	Madera	12.5	9.9	PG&E	W,Ag	52	closed		Bill Lax	209-665-5791	1990	1994
43	Tracy Biomass Plant	Tracy	San Joaquin	21.5	21.0	PG&E	UW,W,Ag	131	open		Kevin Kolnowski	925-431-1431	1990	
67	Colmac Mecca Project	Mecca	Riverside	47.0	45.0	SCE	UW,Ag	270	open		Graeme Donaldson	760-396-2554	1992	
68	Delano II	Delano	Kern	22.9	22.9	SCE	UW,Ag	145	open		John Jensen	661-792-3067	1994	
	Sierra Pacific Anderson	Anderson	Shasta		4.0	PX	W	50	open		Bob Ellery	530-378-8179		
<div> <div>Key</div> <div> <div>Ag - agricultural wastes</div> <div>An - animal wastes</div> <div>MSW - municipal solid wastes</div> <div>UW - urban wood wastes</div> <div>V - virgin wood</div> <div>W - wood wastes</div> </div> <div> <div>N/A - Not Applicable</div> <div>NO - Not Obtained</div> </div> </div>														

# Steam-Only

## California Energy Commission Biolist California Direct Combustion Biomass Facilities - November, 1999

#	Project Name	City	County	Gross (MW)	Contract (MW)	Utility	Fuel	kBDT per yr.	Status	Remarks	Contact	Phone	Operated Year	Date of Shutdown
9	Michigan California Lumber	Camino	El Dorado	N/A	N/A	N/A	W	82	open		Ray Laueri	916-644-2311	1970	
8	Hambro Forest Products	Crescent City	Del Norte	N/A	N/A	N/A	W	6	open		Dwayne Reichlin	707-464-6131	1974	
47	Girvan Lumber Co., Inc.	Redding	Shasta	N/A	N/A	N/A	W	4	open		Baghn Ostrander	916-244-9710	1974	
55	Hi-Ridge Lumber Company	Yreka	Siskiyou	N/A	N/A	N/A	W	7	open		Gerald Bendix	916-842-4451	1977	
18	Schmidbauer Lumber Co.	Eureka	Humboldt	N/A	N/A	N/A	W	2	open		Larry McCracken	707-443-7024	1978	
34	Masonite Corporation	Ukiah	Mendocino	N/A	N/A	N/A	W	55	open		Bill Stancer	707-462-2961	1978	
49	Central Valley	Central Valley	Shasta	N/A	N/A	N/A	W	46	closed	phone disconnected	Darryl Darmin	916-275-8812	1978	1994
32	Little Lake Industries, Inc.	Willits	Mendocino	N/A	N/A	N/A	W	4	closed		Fred Witzel	707-459-5395	1979	1992
57	Tri-Valley Growers Plant 9	Modesto	Stanislaus	N/A	N/A	N/A	W,Ag	3	open		Mike Diroll	209-578-3882	1980	
4	Louisiana Pacific, Oroville	Oroville	Butte	N/A	N/A	N/A	W	96	converted	converted to natural gas	Bill Webb	916-534-6604	1987	?
54	Stone Forest Industries	Happy Camp	Siskiyou	N/A	N/A	N/A	W	13	?		Richard Davis	916-493-2231	1987	?
61	Lindsay Olive Growers	Lindsay	Tulare	N/A	2.2	SCE	Ag	20	dismantled	elec dismantled			1987	1991
58	Crane Mills	Paskenta	Tehama	N/A	N/A	N/A	W	23	?		John Crane	916-833-5362	1989	?
1	Hudson Lumber	San Leandro	Alameda	N/A	N/A	N/A	W	6	converted	converted to natural gas	Dave Berg	510-351-5872	?	?
2	Georgia Pacific Corp.	Martell	Amador	N/A	N/A	N/A	W	22	open		Brian Bennett	209-689-1221	?	
13	Sierra Pacific Industries	Arcata	Humboldt	N/A	N/A	N/A	W	4	open		Scott Leiby	916-378-8000	?	
14	Louisiana Pacific, Arcata	Arcata	Humboldt	N/A	N/A	N/A	W	51	open		Dick Kayser	707-822-5961	?	
37	Georgia Pacific Corp.	Forest Hill	Placer	N/A	N/A	N/A	W	6	?		Joe Hughes	916-367-2241	?	?
56	Louisiana Pacific, Cloverdale	Cloverdale	Sonoma	N/A	N/A	N/A	W	10	closed	moved to Ukiah	Gary Van Patten	707-894-8952	?	?

Key	
Ag - agricultural wastes	
An - animal wastes	
MSW - municipal solid wastes	
UW - urban wood wastes	
V - virgin wood	N/A - Not Applicable
W - wood wastes	NO - Not Obtained

## **APPENDIX VII – ECONOMIC EVALUATION**

- **Add new Appendix VII-C on Summary of Biomass Benefits Studies:**

### **Summary of Biomass Benefits Studies**

Three different reports describing the benefits of biomass electric power plants in California were reviewed. The studies, all completed in 1997 (and cited in full at the end of this section), were done by: Natural Resources Strategic Services (NRSS) of Valencia, California for the U.S. Department of Energy and the California Energy Commission; California Biomass Energy Alliance (CBEA), work performed by Reese-Chambers Systems Consultants, submitted to the California Environmental Protection Agency; and Future Resources Associates (FRA) of Berkeley, California for the National Renewable Energy Laboratory.

All three of these studies examined the benefits to California of the operating system of biomass electric power plants, about 60 of which were built in the state from 1980 to 1996. About half of these plants continue to operate. The biomass feedstocks for these plants include wood processing residues, forest residues, agricultural residues and urban wood waste. Estimates of total biomass feedstocks consumed by the biomass power industry at its peak range from about 6 to 8 million bone dry tons per year.

#### **NRSS Study**

The NRSS study relied mainly on the CEC biomass data base for its statistical data on the biomass power industry. The study results are not referenced to a particular year, however, the CEC data used in the study is for the year 1991. The study describes and estimates annual dollar values for the following benefit areas: reduced air pollutant emissions from open-field burning of agricultural and forest wastes; diversion of waste materials from landfills; wildfire reduction; improved forest health; rural income and employment; and electricity generation. Simple spreadsheet models were employed to calculate benefits in each of these areas. The results are summarized in the attached table. Greenhouse gas reduction was cited as an additional benefit, but not quantified.

#### **CBEA Study**

The CBEA study used data from a survey of 36 biomass power plants operating as of 1994. Annual dollar values were estimated for the following benefit areas: reduced air pollutant emissions, including greenhouse gases; increased water yield from improved forest management; wildfire risk reduction; diversion of waste materials from landfills; energy diversity; and employment. A high and low range of benefits was estimated in each of these categories. The results are summarized in the attached table. Improved forest health and productivity and improved orchard productivity were cited as additional benefits but not quantified.

#### **FRA Study**

The FRA study provides a detailed history of the development of California's biomass power industry and generally describes the areas of environmental benefits provided by this industry. The benefit categories described include: reduced fuel loading in forests; diversion of waste

materials from landfills; and reduced emissions from open burning. Employment is also discussed. No monetary valuation of benefits is included in this study.

Comparison of Estimated Benefits  
(In Million \$/year)

Benefit Category	NRSS Study	CBEA Study	
		Low	High
Reduced Air Emissions		35	159
Ag Burning	15.395		
Forestry	2.020		
Greenhouse Gas Reduction	--	(incl. in air emissions)	
Diversion from Landfill Disposal		55	55
Ag	21.825		
Other	20.624		
Wildfire Reduction	23.291	17	54
Forest Health	0.560		--
Water Yield	--	55	148
Rural Income/Employment	233.111	55	55
Electricity Generation (Energy Diversity)	156.111	29	29
Total Estimated Value of Benefits	472.932	246	500

## Studies Cited

Benefits of Biomass Power in California, Natural Resource Strategic Services with assistance from Appel Consultants Inc., prepared for U.S. Dept. of Energy, Western Regional Biomass Energy Program, and California Energy Commission, August 1997.

Biomass Energy in California: Valuation of External Benefits, California Biomass Energy Alliance, submitted to California Environmental Protection Agency, December 2, 1996 (revised January 7, 1997).

The Environmental Costs and Benefits of Biomass Energy Use in California, Future Resource Associates Inc., prepared for National Renewable Energy Laboratory, May 1997.